UCRL-JC-126820 Abs

THIRTEENTH INTERNATIONAL CONFERENCE ON LASER INTERACTIONAND RELATED PLASMA PHENOMENA

Monterey, California
April 13-18, 1997

Protection of final optics with cryogenic liquid droplets* R. W. Moir, LAWRENCE LIVERMORE NATIONAL LABORATORY, Livermore, California, USA. A burst of x rays and vaporized debris from high yield targets can damage the final optics in NIF. Nobel gases such as Xe have been proposed to protect final optics from target produced x rays. Some problems with the use of Xe gas are the large amount of gas involved, heat transfer to the cryogenic target, and non-uniform index of refraction due to turbulence interfering with focusing the light. The idea here is to provide the gas in the form of many small closely spaced liquid droplets injected in front of the optics only when needed just before a high yield shot. The laser light that is absorbed will cause evaporation of the liquid and spreading of the gas. The density of liquid droplets is such that ~95% of laser light passes through to the target. The light absorption (assumed to be 50% of the 5% at an intensity of 3.6×10^{9} W/cm^2) causes the xenon droplets to evaporate and spread uniformly such that the x rays from 11 eV to 2 keV are appreciably attenuated when they arrive 40 to 70 ns later at the optical surface. X rays above 3 keV and below 10 eV are not attenuated but their intensities are falling off in this range anyway. Typical droplet sizes are ~10 μm radius with a spacing of ~0.4 mm. In addition to protection from x rays, vaporized target debris will be prevented from condensing on the optics due to the 0.2 mg/cm^2 of xenon. These droplets might be produced with technology similar to ink jet technology. The cryogenic liquid xenon would be easily pumped away from the chamber and it need be employed only for high yield shots. We conclude the idea might work and recommend further analysis and experimental investigation. Droplet generator parameters are given in the table below sized to protect one of the 192, 38 × 38 cm fused SiO_2 slab blast in NIF.

	droplet radius, μm	droplet spacing, m m	holes per droplet generator (1 cm × 38 cm)	laser light lost	energy per Xe atom, e V
X-ray attenuator	11	0.43	20,000	5%	2
Target debris attenuator	11	4.8	165	0.004%	2

Discussions are gratefully acknowledged with Mike Feit, Alex Rubenchik, David Eder at LLNL and by Min Chen at MIT, and Al Pisano at UC Berkeley.

*This work performed under the auspices of the United States Department of Energy by Lawrence Livermore National Laboratory under contract number W-7405-ENG-48.